NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

EARTH RESOURCES LABORATORY

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MTF

SEA REMOTE SENSING PROGRAM

BILOXI BAY REMOTE SENSING STUDY

AUGUST 8, 1972

REMOTE MEASUREMENTS

LIGHT AIRCRAFT

REPORT NO 041

JANUARY 26, 1973

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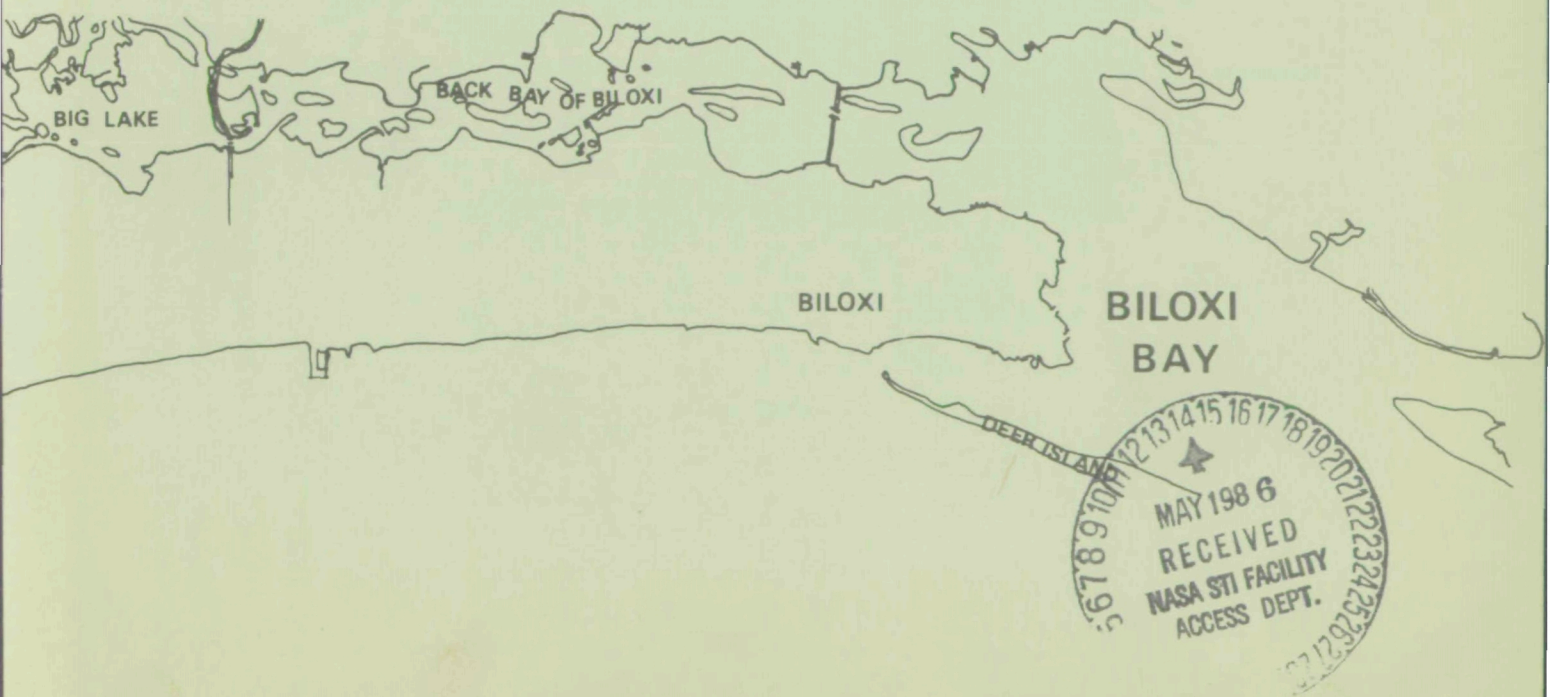

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I. INTRODUCTION

A joint study of Biloxi Bay by Scientists of the Gulf Coast Research Laboratory (GCRL) and the NASA Earth Resources Laboratory (ERL) has been planned.

The objectives of the study are to evaluate the usefulness of remotely sensed data which may be obtained from a light aircraft (photography, spectrometer, infrared scanner imagery, and PRT-5 data) in characterizing the water conditions in Biloxi Bay, and furthermore, from the combined remote and surface measurements to study the interaction between the processes taking place in Biloxi Bay and nearby waters of Mississippi Sound.

Responsibility for surface measurements to be conducted bi-weekly over a period of one year rests with GCRL. Monthly remote measurements in conjunction with one of the bi-weekly surface measurement experiments are to be conducted by ERL. This report presents remote data collected during the first combined measurement experiment.

The information contained in Sections II, IV, V, VI and VII of this report was prepared by Lockheed Electronics Corporation, support contractor to the Earth Resources Laboratory.

II. DATA ACCURACY SUMMARY.

Some of the RS-18 Scanner data collected during this mission was not useable due to instrument malfunctions. This report concerns itself only with the data displayed in the products contained in the rear pocket. The thermal data is presented in the form of a composite print (see back pocket) of one strip of gray level thermal map (top row, Airborne Radiometric Temperature, flight line 1-1) and three strips of standard (analog tape to film) RS-18 infrared imagery (2nd, 3rd and 4th rows, resp flight lines 1-1, 3-1 and 1-2).

Infrared Scanner Imagery

The infrared imagery (analog tape to film), has not been subjected to corrections for velocity/height ratio and therefore display differences in scale. Within a strip of imagery, scale differences generally exist for directions aligned with the flight orientation as compared to distances across the line of flight. Imagery strips taken at the same altitude may display marked differences in scale in the direction of flight, while across flight direction scales are about the same.

Scale differences have been established along and across the flight path for the infrared imagery at the two different altitudes by measuring seven distances in both directions. (East-west and north-south) Positional errors for the various scales are as follows:

	Average Scale	Percent Deviation In scale	Positional Accuracy
Line 1-1			
E-W direction	1"=2025 ft.	2%	± 25 ft.
N-S direction	1"=2540 ft.	60%	±600 ft.
Line 1-2			
E-W direction	1"=4700 ft.	2%	± 50 ft.
N-S direction	1"=4400 ft.	10%	±400 ft.

Positional errors for line 3-1 are approximately the same as for line 1-1.

The low accuracies in the N-S direction (parallel to the scanning motion of the sensor) are probably caused by malfunctions of the roll gyro.

No atmospheric corrections have been applied to this product and some variations in film density across the scan may be seen due to change in atmospheric path length with scan angle. Relationships between image densities, showing cooler and warmer areas, have not been analyzed with respect to temperature values.

Airborne Radiometric Temperatures

The aerial infrared data, in digital thermal map format, produced for this mission are considered suitable for quantitative analysis. The digital thermal data has been corrected for atmospheric effects. Due to malfunctioning of the infrared scanner platform most remote data collected during this mission showed too much distortion for the present processing procedure of transformation into gray level temperature bands. Only one strip (flight line 1-1, altitude 2000 ft over Back Bay of Biloxi) was thus processed.

Positional errors associated with the gray level thermal map are expected to be somewhat more erratic than those associated with the identical infrared imagery line due to the fact that features are not as sharply defined and processing of this data into continuous strip requires multiple steps (see Product Information Sheet (3)). It is anticipated that the accuracy of the temperatures and their associated position will be increased in future missions due to improved data processing techniques.

There are some discrepancies between the RS-18 temperatures and those reported by boats as well as discrepancies between the gray level display (digital) and the infrared imagery (analog tape to film). At this time, these differences are attributed to processing techniques, which are still under development, and to the effects of improper scanner operation which have not

been analyzed in detail.

The limited amount of digital thermal data prevented proper statistical analysis for establishing relative and absolute temperature accuracies. From the comparison of the 12 boat station temperatures with the gray levels as displayed in the digital thermal map, it was determined that 50% of these points fell within the correct gray level. Of the remaining six points all except one deviated only by one gray level from the correct one (the one point is located in the abnormal hot zone of Big Lake area), i.e., 50% of twelve points are correct within $1^{o}C$; 90% within $2^{o}C$.

Aerial Photographs

The serial photographs collected for this mission are considered suitable for the intended purposes, e.g., qualitative comparisons of water colors, turbidity patterns, bottom features and relative water surface roughness and actual flight path determination.

Airborne radiometer data (PRT-5) were collected as "back-up" for the RS-18 data and are available in the ERL Data Lab in unreduced form if required. Airborne spectrometer data (E-20D) were also collected. Processing techniques are under development and this data may be available at a later date depending on technique development progress.

Detailed discussion of aircraft and sensor performance are located in section IV, Flight Operations Report. Specific data parameters may be found in section V, Data Product Information Sheets.

III EARTH RESOURCES LABORATORY

FLIGHT REQUEST FOR ERL TWIN BEECH

1. Program or Project:

   Biloxi Bay Remote Sensing Study

2. Requesting organization(s) and individual(s):

   Requested by Gulf Coast Research Laboratory under contract No. NAS9 12965

   Project coordinator - GCRL - Mr. J. Y. Christmas
   Technical Monitor - ERL - Dr. B. H. Atwell

3. Date of flight:

   8 August 1972

4. Flight requirements:

   The experiment area extends from approximately $89^{o}00'W$ to $88^{o}47'W$ and from approximately $30^{o}21'20"N$ to $30^{o}25'25"N$; covering the Biloxi Bay, the ship channel area entering the bay and the South Coastline adjacent to the city of Biloxi.

   This mission is to be flown at altitudes of 2,000, 5,000 and 10,000 feet, according to flight lines 1, 2, and 3 - see Flight Line and Station Location Map in back pocket.

5. Flight contraints:

   Cloud cover : $\leq$ 10%

   Sun angle : $\geq$ 30%

   Other contraints : Maximum effort should be made to adhere to ground speeds and altitudes (specified on Flight Requirements in Mission Flight Plan) and flight track (depicted on flight line map). All sensor settings should be optimized for recording over water. Roll should not exceed 15^{o}. Photographic sensors should be regulated for 30% forward overlap.

6. Communication requirements:

   Telephone contact at MTF: Mr. H. W. Adams 601-688-4824
   Mr. E. F. Zetka 601-688-4255

   Telephone contact will be maintained between ERL and GCRL starting the evening prior to the mission. Initial contact on mission day will be 0600 hrs.

System	Frequency	Purpose
Collins	6.9825 mHz	Comm. between MTF and ERL light aircraft

7. Sensor requirements:

Sensors: Operate all sensors with optimized settings for water.

A - PRT-5 Radiometer

Operate on 3Hz response
Spectral range 8-14 microns

B - Cameras - Hasselblad (1) and (2)

	Film Type	Filter	Lens	Overlap
No. (1)	Color (2448)	Wratten HF-4	40mm	30% forward
No. (2)	Color IR(2443)	Wratten 15	40mm	30% forward

C - RS-18 Scanning Radiometer

Spectral range 8-14 microns nominal

D - E-20D Spectrometer

Detector - optimize for 400 - 660 nanometers region.
Scanning intervals - 1/sec.

8. Calibration target requirements:

- Deploy gray scale and tricolor targets prior to 0900 on mission day.
- Take contact temperatures of 2%, 4%, 16%, 32%, 64% and 90% gray scale targets at flyover.
- Calibration targets will be flown at 2000 feet altitude after completion of other flight lines.

9. Deliver data to:

ERL - Data Lab.

TEST SITE	AIRCRAFT	FLIGHT DATE
Biloxi Bay	TWIN BEECH	8 August 1972

FLIGHT LINE NUMBER	FLIGHT ALTITUDE Feet	FLIGHT LINE LENGTH NM	TIME OF DAY CDT	SENSORS (IDENTIFY EACH SENSOR) Hasselblad No. 1	Hasselblad No.2		PRT-5	RS-18	Spectro Meter
1-1	2,000	09.3	0939 0942	"	"		"	"	"
2-1	2,000	06.3	0946 0948	"	"		"	"	"
3-1	2,000	09.2	0952 0956	"	"		"	"	"
1-2	5,000	09.3	0919 0922	"	"		"	"	"
2-2	5,000	06.3	0926 0928	"	"		"	"	"
3-2	5,000	09.2	0932 0936	"	"		"	"	"
1-3	10,000	09.3	0900 0903	"	"		"	"	"
2-3	10,000	06.3	0907 0909	"	"		"	"	"
3-3	10,000	09.2	0912 0916	"	"		"	"	"
16-1	2,000	Target Pond	*	"	"		"	"	"

* Fly upon completion of other lines

NOTE: COMPLETE A SEPARATE SHEET FOR EACH DIFFERENT TEST SITE OVERFLIGHT REQUIRED.

IV. FLIGHT OPERATIONS REPORT

1. Flight Summary

A. Project: Biloxi Bay Remote Sensing Study
Mission 038-1

B. Requesting organization(s) and individual(s)

Requested by Gulf Coast Research Laboratory under contract No. NAS9 12965

Project coordinator - GCRL - Mr. J. Y. Christmas
Technical monitor - ERL - Dr. B. H. Atwell.

C. Mission Date: 8 August 1972

2. Flight Requirements and Flight Description

A. Aircraft Performance

1. The Flight Lines in Biloxi Bay were flown as follows (according to inflight logs)

Line	Run	Alt.	Time - CDT Start	Stop	Heading	(Approx) Ground Speed Kts
1	1	2K	08:42	08:46	ESE	140
2	1	2K	08:52	08:54	SE	140
3	1	2K	08:58	09:02	W	140
1	2	5K	09:21	09:24	ESE	150
2	2	5K	09:31	09:33	SE	150
3	2	5K	09:39	09:43	W	150
1	3	10K	10:04	10:08	ESE	165
2	3	10K	10:18	10:20	SE	165
3	3	10K	10:24	10:28	W	165
16	1	2K	10:48	10:48	N	140

2. Actual flight line positions and ground coverage are indicated on the 1:62,500 scale USGS Quadrangles, which have been reduced to 8½" x 11" sheets, located in the back pocket. The flight paths have been plotted by means of the Hasselblad and RS-18 Scanner imagery. The index maps are prepared separately for the photographic sensors and the scanner imagery. Each of these are further divided into plots for 2,000, 5,000, and 10,000 feet altitude flights. Actual ground coverage is shown en bloc for the scanner imagery and photographic coverage is outlined for intermittent frames.

Flight indexes included as follows:

a. Hasselblad Color and Color IR - 2,000 ft.
b. Hasselblad Color - 5,000 ft.
c. Hasselblad Color -10,000 ft.
d. RS-18 Imagery - 2,000 ft.
e. RS-18 Imagery - 5,000 ft.

B. Flight Constraints:

1. None due to weather, however, the infrared scanner malfunctioned as noted in Data Product Information Sheet (3).

C. Communications:

No problems were encountered in maintaining communications as planned.

3. Sensors

A. Configuration

The following sensors were operated on each of the flight lines:

1. Hasselblad Camera (No. 1)
   Focal length 40mm, format 70mm film
   30% forward overlap requested - 10-30% obtained.
   Film: 2448 (color)
   Filter: HF-4
   Shutter Speed: 1/250 sec.

2. Hasselblad Camera (No.2)
   Focal length 40mm, format 70mm film
   30% forward overlap requested - 10-30% obtained
   Film: 2443 (color IR)
   Filter: W 15
   Shutter Speed: 1/250 sec

3. PRT-5 Radiometer
   Spectral range: 8-14 microns
   Filter: 3Hz

4. RS-18 Scanning Radiometer
   Filter: 8-14 microns
   V/H: Setting according to ground speed and altitude

5. E-20D Spectrometer
   Detector: Silicon
   Gain: Optimum operational setting. See inflight logs(available from ERL Data Lab.)

6. Data System includes

   a. Magnetic Tape Recorder
   b. IRIG time code generator
   c. Intercom
   d. WWV Receiver

B. Anomalies or Malfunctions

1. Hasselblad cameras (1) and (2).
   No malfunctions observed during flight.

2. PRT-5 Radiometer
   No anomalies noted during flight

3. RS-18 Scanning Radiometer

   a. Modulation of video output by DC/AC inverter

   b. During flight of line 1-1 and line 1-2, the video signal shifted negative 2 volts at 12 second intervals causing streaks (Possibly due to proximity of ERL aircraft to Keesler AFB radar).

   c. During flight of lines 1-2, 1-3, 2-1, 2-3, 3-2, and 3-3 the roll gyro moved erratically from stop to stop affecting proper recording.

4. Calibration targets

The MTF target pond was photographed at 2,000 ft. altitude and is visible on the Hasselblad color photography and the scanner infrared imagery. The pond water temperatures were taken as described under item 9 of the Flight Request. Data is available from the ERL Data Lab.

Calibration targets (color targets) were not photographed.

DATA PRODUCT INFORMATION SHEET (1)

1. Program or project: Biloxi Bay Remote Sensing Study

2. Sensor: Hasselblad camera (1); Focal length 40mm

3. Site: Biloxi Bay

4. Date: 8 August 1972

5. Mission number: 038-1

6. Roll number: 1

7. Flight lines on this product: 1-1, 1-2, 1-3; 2-1, 2-2, 2-3; 3-1, 3-2 3-3; and 16-1

8. Data start time: 08:42:57 CDT

9. Data stop time: 10:48:50 CDT

10. Format: 70mm film; image 55x55mm

11. Altitude:
    - Run 1 - 2,000 ft.
    - Run 2 - 5,000 ft.
    - Run 3 - 10,000 ft.

12. Scale of imagery:
    - Run 1 - 1:15,030
    - Run 2 - 1:37,600
    - Run 3 - 1:75,200

13. Coverage per frame:
    - Run 1 - 2,800 x 2,800 ft.
    - Run 2 - 6,900 x 6,900 ft.
    - Run 3 - 13,800 x13,800 ft.

14. Number of frames: 120 (See No. 22 for frames by line).

15. Overlap (forward): 10-30%

16. Overlap (side): None

17. Film: 2448 - Kodak Ektachrome MS Aerographic

18. Filter/spectral range: Wratten HF-4

19. Transparency:

    Positive: 1 copy each of frames under item # 22

    Negative: 0

20. Paper

    Positive: 0

    Negative: 0

21. Footage: 24 ft./110 frames

22. List of frames/time:

Line	Run	Frame No.'s	Start/stop	Time	(subtract 5 hrs for CDT)
1	1	0070-0044	13:42-13:46	GMT	
2	1	0043-0026	13:52-13:54	GMT	
3	1	0025-0001	13:58-14:02	GMT	
1	2	0071-0079	14:21-14:24	GMT	
2	2	0080-0086	14:31-14:33	GMT	
3	2	0087-0099	14:39-14:43	GMT	
1	3	0100-0106	15:04-15:08	GMT	
2	3	0107-0110	15:18-15:20	GMT	
3	3	0111-0116	15:24-15:28	GMT	
16	1	0117-0120	15:48-15:48	GMT	

23. Processing: Kodak EA-5 Chemicals/Processor Model 1811.

24. Atmospheric corrections: N/A

25. Special product: N/A

26. Quality assessment and anomalies:

    IMAGE QUALITY: - Fair

    SYSTEM MALFUNCTION: - None

    EXPOSURE: - Underexposed ~1-2 f-stops

PROCESSING:	- Standard
RESOLUTION:	- Compatible with system
ATMOSPHERIC CONDITIONS:	- 7 to 10 miles visibility; light haze at 10,000 ft.; low light level
CLOUD COVER:	- High thin scattered clouds, runs 1-2 Run 3 had scattered clouds at 9000 ft.
HAZE:	- Thin haze
FLIGHT ALIGNMENT:	- Good
AIRCRAFT CRAB ANGLE	- 0^{o}
GENERAL REMARKS:	- Combination of low light level and use of HF-4 filter produced a greenish image.

DATA PRODUCT INFORMATION SHEET (2)

1. Program or project: Biloxi Bay Remote Sensing Study

2. Sensor: Hasselblad camera (2); Focal length 40mm

3. Site: Biloxi Bay

4. Date: 8 August 1972

5. Mission number: 038-1

6. Roll number: #2

7. Flight lines on this product: 1-1, 1-2 and 1-3 (No photographs were recorded during runs 2 and 3)

8. Data start time: 08:42:57 CDT

9. Data stop time: 09:02:14 CDT

10. Format: 70mm film; image 55x55mm

11. Altitude: 2,000 ft.

12. Scale of imagery: 1:15,000

13. Coverage per frame: 2,800 ft. by 2,800 ft.

14. Number of frames: 75

15. Overlap(forward): 30%

16. Overlap (side): None

17. Film: 2443 Kodak Aerochrome Infrared Film

18. Filter/spectral range: Wratten 15

19. Transparency:

    Positive: 1 copy each of frames under item #22

    Negative: 0

20. Paper

    Positive: 0

    Negative: 0

21: Footage: 15 Ft./75 frames

22. List of frames/time:

Line	Run	Frame No.'s	Start/stop	Time (subtract 5 hrs for GMT CDT)
1	1	122-147	13:42-13:46	GMT
2	1	148-165	13:52-13:54	GMT
3	1	166-197	13:58-14:02	GMT

23. Processing: Kodak EA-5 chemicals/Processor Model 1811

24. Atmospheric corrections: N/A

25. Special product: N/A

26. Quality assessment and anomalies:

IMAGE QUALITY	- Fair (Run 1) No imagery for runs 2 and 3.
SYSTEM MALFUNCTION	- No imagery recorded for runs 2 and 3. Cause unknown.
EXPOSURE	- Underexposed approximately ~1-2 f stops.
PROCESSING	- Standard
RESOLUTION	- Compatible with system

ATMOSPHERIC CONDITIONS	- 7 to 10 miles visibility with thin haze at 10,000 feet; low light level.
CLOUD COVER	- High thin scattered clouds
HAZE	- Thin haze
FLIGHT ALIGNMENT	- Good
CRAB ANGLE	- 0^{o}
GENERAL REMARKS	- A combination of low light level, filtration and low altitude produced a greenish image.

DATA PRODUCT INFORMATION SHEET (3)

1. Program or project: Biloxi Bay Remote Sensing Study

2. Sensor: RS-18 Scanning Radiometer

3. Product: (A) RS-18 Infrared Imagery (analog tape to film)

   (B) Airborne Radiometric Temperature (digital thermal format)

4. Site: Biloxi Bay

5. Date: 8 August 1972

6. Mission number: 038-1

7. Roll number: N/A (Initial data is recorded on magnetic tape (in flight). Subsequent "hard copy" products are produced in laboratory.

8. Flight lines on this product: 1-1, 1-2, 3-1

9. Data start time: 08:42:57 CDT

10. Data stop time: 09:24:48 CDT

11. Format: 70mm - continuous strip of imagery coincident with flight path.

12. Altitude: Line 1-1 - 2,000 ft.
    Line 1-2 - 5,000 ft.
    Line 3-1 - 2,000 ft.

13. Scale of imagery: (Along line of flight) approximately
    1:24,000, for run 1, 2,000 ft. altitude
    1:55,000, for run 2, 5,000 ft. altitude
    1:110,000, for run 3, 10,000 ft. altitude

14. Coverager per frame: Across line of flight: 4,760 ft. at 2,000 ft.
    11,900 ft. at 5,000 ft.

15. Number of frames: 1 strip of imagery/flight line

16. Overlap (forward): Contiguous

17. Overlap (side): None

18. Film: 2479 RAR - used for initial data recording from tape to film.

19. Filter/spectral range: 8-14 microns nominal (Sensor response function available at ERL Data Lab)

20. Transparency:

    Positive: 0

    Negative: 0

21. Paper

    Positive: 1

    Negative: 0

22. Footage: Film record for 2000 ft. altitude approximately 30" x 70mm
    Film record for 5000 ft. altitude approximately 15" x 70mm

23. List of frames/time:

Line	Run	Frame No.'s	Start/Stop	Time (subtract 5 hrs for CDT)
1	1	-	13:42:57/ 13:46:27	GMT
3	1	-	13:58:34/ 14:02:48	GMT
1	2	-	14:21:10/ 14:24:48	GMT

24. Processing:

    A. RS-18 Infrared Imagery:
    The data recorded on magnetic tape during flight is transcribed in the laboratory to film, producing a film negative. The (positive) paper products as shown are produced from this film photographically (contact printing).

    B. Airborne Radiometric Temperature - Gray Level Map:

    For processing details of this product see item 26 - special product.

25. Atmospheric corrections:

The total scanning angle of this sensor is 100° across track which leads to marked differences in atmospheric path lengths between nadir and the left and right extremes of the field of view. Corrections for atmospheric effects are included in the processing of the data for the gray level map to result in a temperature field consistent with the observed temperatures provided by the boats. Item 27E of this sheet lists actual corrections applied. See Section II Data Accuracy Summary.

No atmospheric corrections have been applied to the infrared imagery (analog tape to film).

26. Special product: AIRBORNE RADIOMETRIC TEMPERATURE/GRAY LEVEL THERMAL MAP

A computer generated gray level map, based on the RS-18 radiometric temperatures has been prepared showing the water surface temperature distribution in 1.0°C increments for line 1-1 only. The map has been adjusted to match the scale of the infrared imagery, approximately 1:24,000. See Section II Data Accuracy Summary.

27. Quality assessment and anomalies:

A. Sensor performance:

1. The shifting of the video signal to a negative voltage at a more or less regular rate during flight line 1-1 and line 1-2 clearly left its marks on the imagery in the form of streaks across the format at 1.5 - 1.75 inch apart.

2. In prior missions the modulation of the DC/AC converter is believed to have caused light bands across the format. No effort has been made at this time to analyze or separate the effects of the voltage shift from the modulation marks.

3. Laboratory assessment of the infrared negatives showed that during the flight of lines 1-2, 1-3, 2-1, 2-3, 3-2 and 3-3 the roll gyro seems to have moved erratically causing a great deal of wave-like distortion in the imagery, thus rendering it nearly useless for interpretative purposes, therefore, only the imagery of lines 1-1, 3-1, and 1-2 are included in this report. For the same reason only line 1-1 was transformed into digital format.

B. Magnetic tape data verification

1. RS-18 Sync. pulse: Calibration quality - good
   Data signal quality - good

2. RS-18 video signal: Calibration quality - good
   Data signal quality - interference in signal at about 12 second intervals on line 1-1; video signal appears to be affected by unstable gyro action

C. Data processing for special product:

1. A/D conversion is accomplished on SDS-930 computer.

2. UNIVAC 1108 computer is used for processing and correction of data and transformation into the gray level thermal map.

D. Quality of special product:

1. Flight alignment - The center line (nadir track) of the gray level map has the same orientation as the flight lines for the Hasselblad photography as indicated on the actual flight line maps in back (pocket). Headings are within 2^{o} degrees of the flight request.

2. Positional accuracies within the gray level thermal map seems to be within 400 ft. The positional errors are primarily due to the following factors.

   a. Differences in scale of the imagery across track and along flight tract. Scale is generally rather constant across track for any one flight line but may vary greatly along the line of flight, with respect to the cross track scale, due to changes in velocity to height ratio of the aircraft.

   b. Difficulties in determining the correct ground speed of aircraft. Correct ground speed is needed to equalize the two scales mentioned under (a) during processing.

   c. RS-18 infrared data for this mission has been processed with the ground speed as <u>estimated</u> during the flight.

   d. The initial gray level images are produced on microfilm, which are enlarged to a suitable size. Establishing the correct enlargement factors and assembling the images is a source of error.

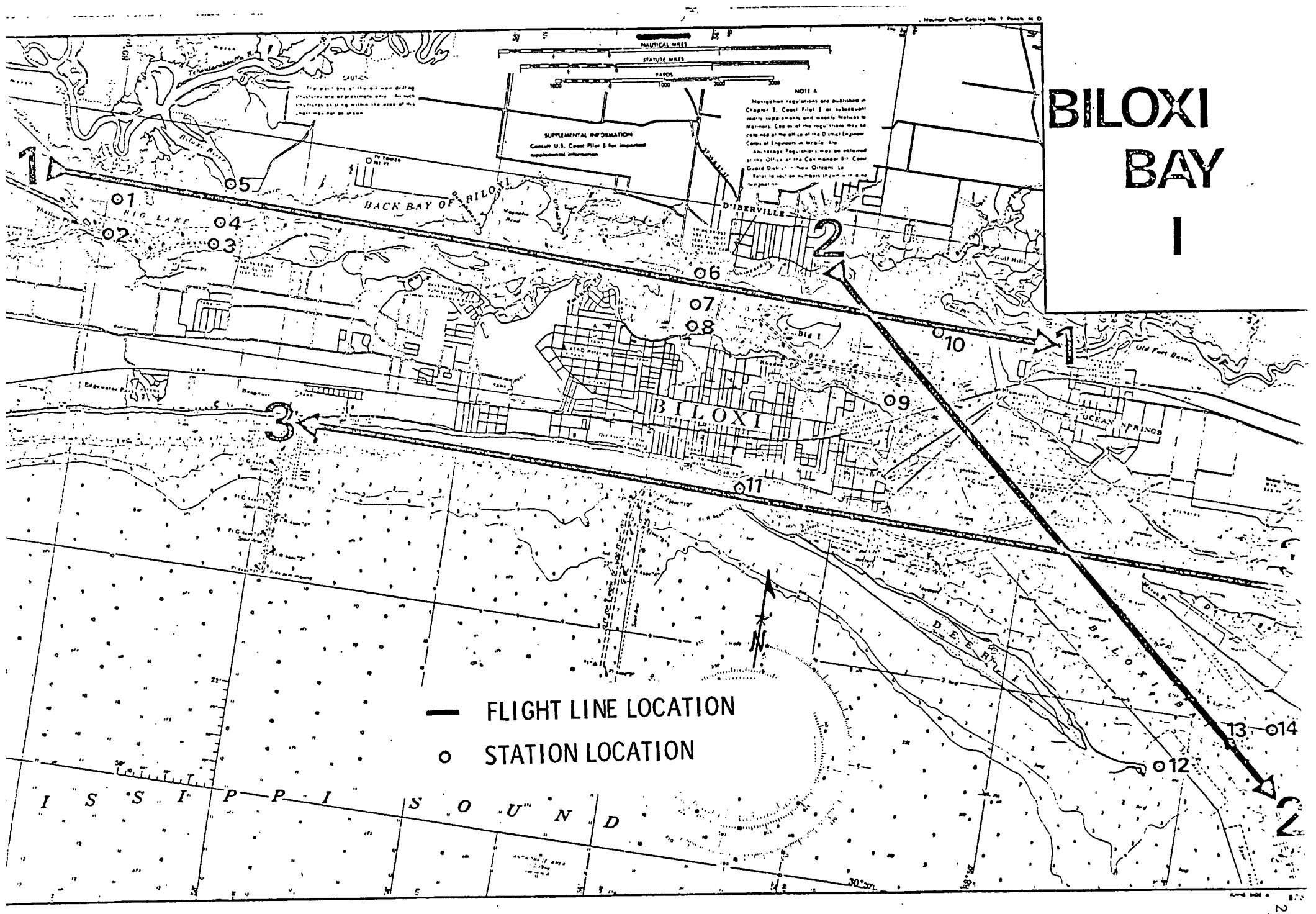
   e. Deviations of aircraft in flight headings.

E. Corrections

The temperature corrections applied during the processing of the special product to reduce the differences in the atmospheric path lengths between nadir and the extremes of the field of view of the scanner are given below, plus the temperature off-set applied to make the scanner temperatures compatible with the temperatures as measured by the boats.

Temperature corrections applied to line 1-1 (2000-ft altitude) in ^{o}C: (facing forward in aircraft)

	LEFT	NADIR	RIGHT
Correction ^{o}C	+5.15	+4.75	+5.15


BILOXI
BAY
I
FLIGHT LINE LOCATION
STATION LOCATION
BACK BAY OF BILOXI
BILOXI
D'IBERVILLE
OCEAN SPRINGS
DEER I.
BILOXI CHAN.
I S S I P P I S O U N D
N
1
2
3
01
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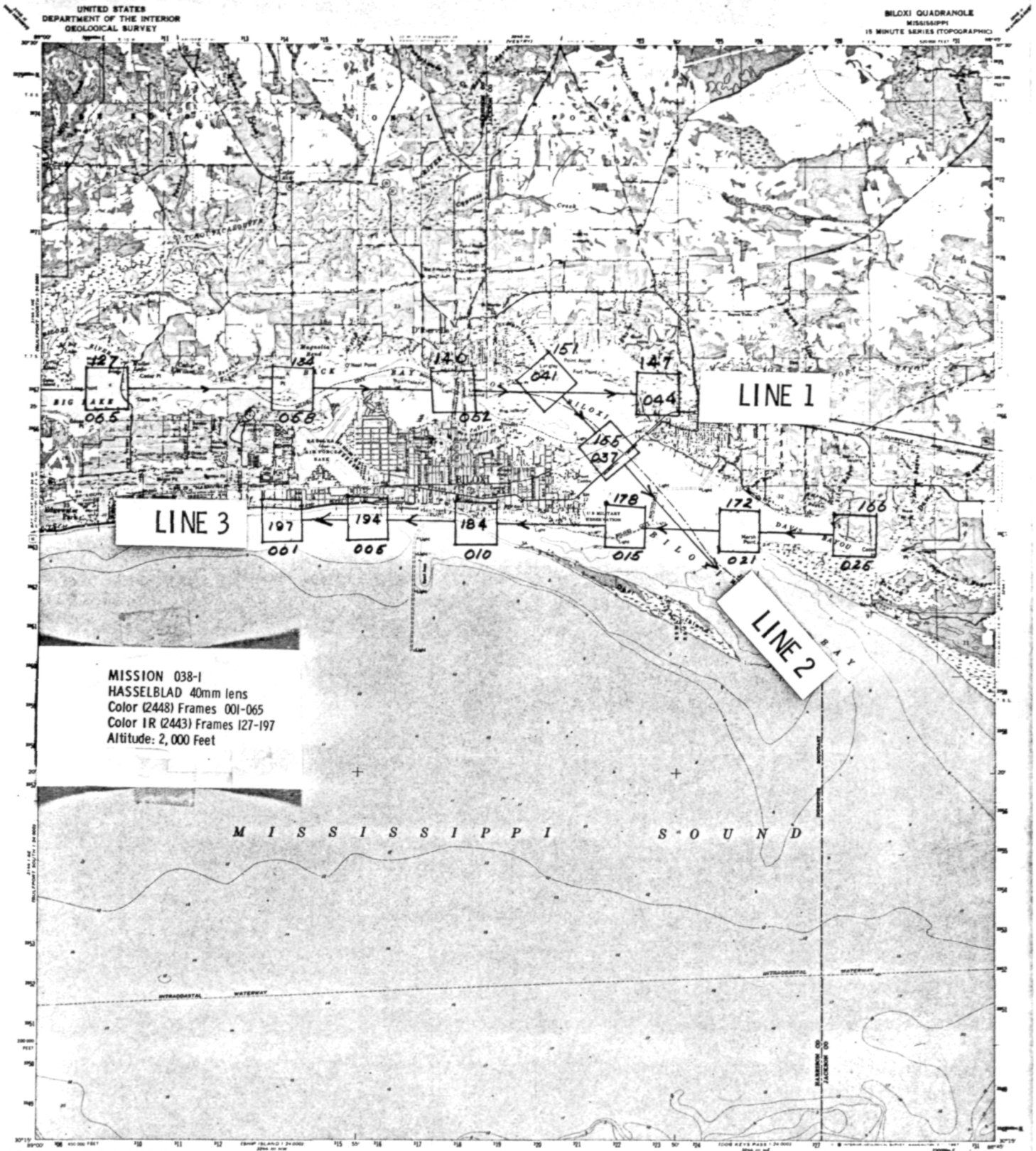
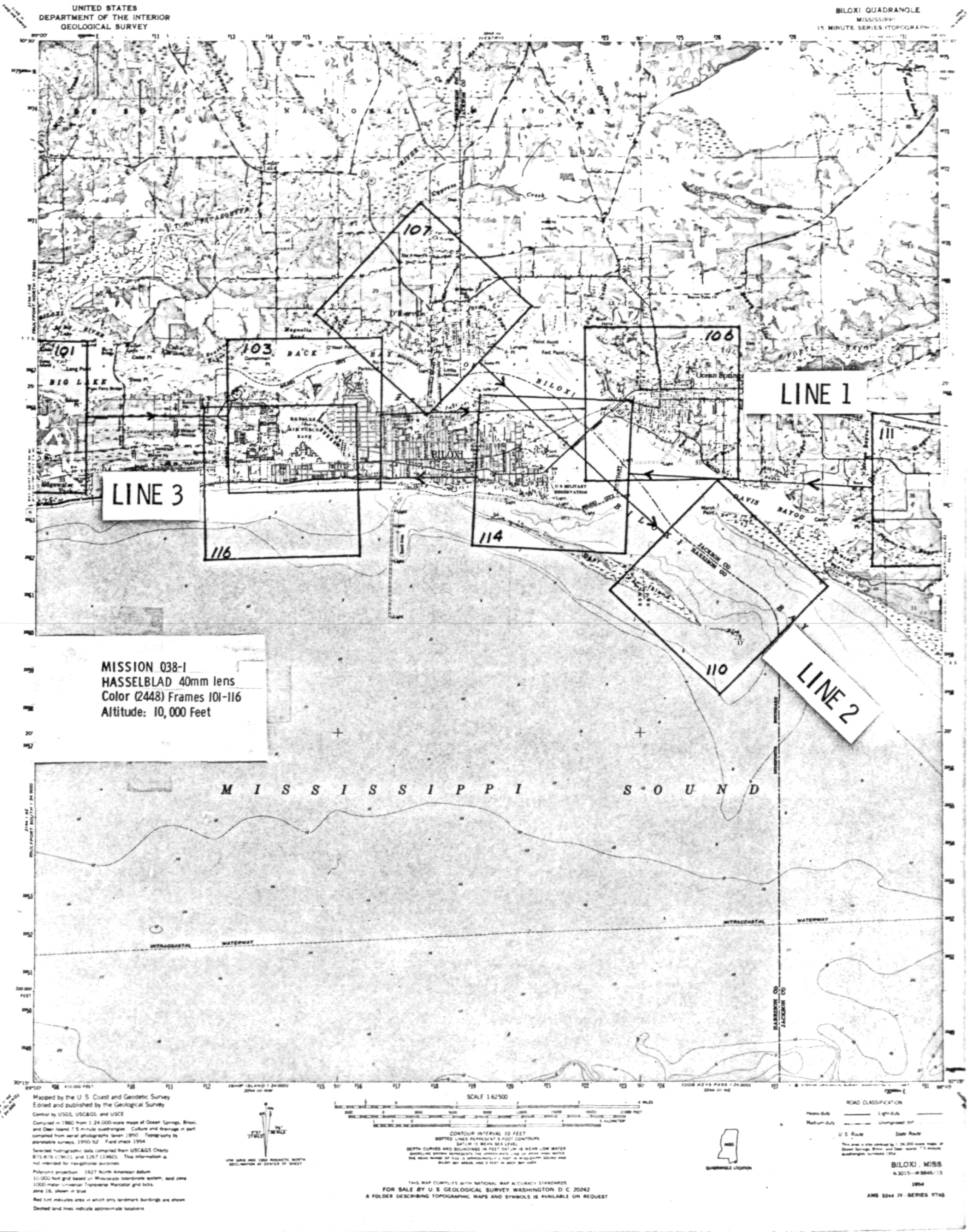
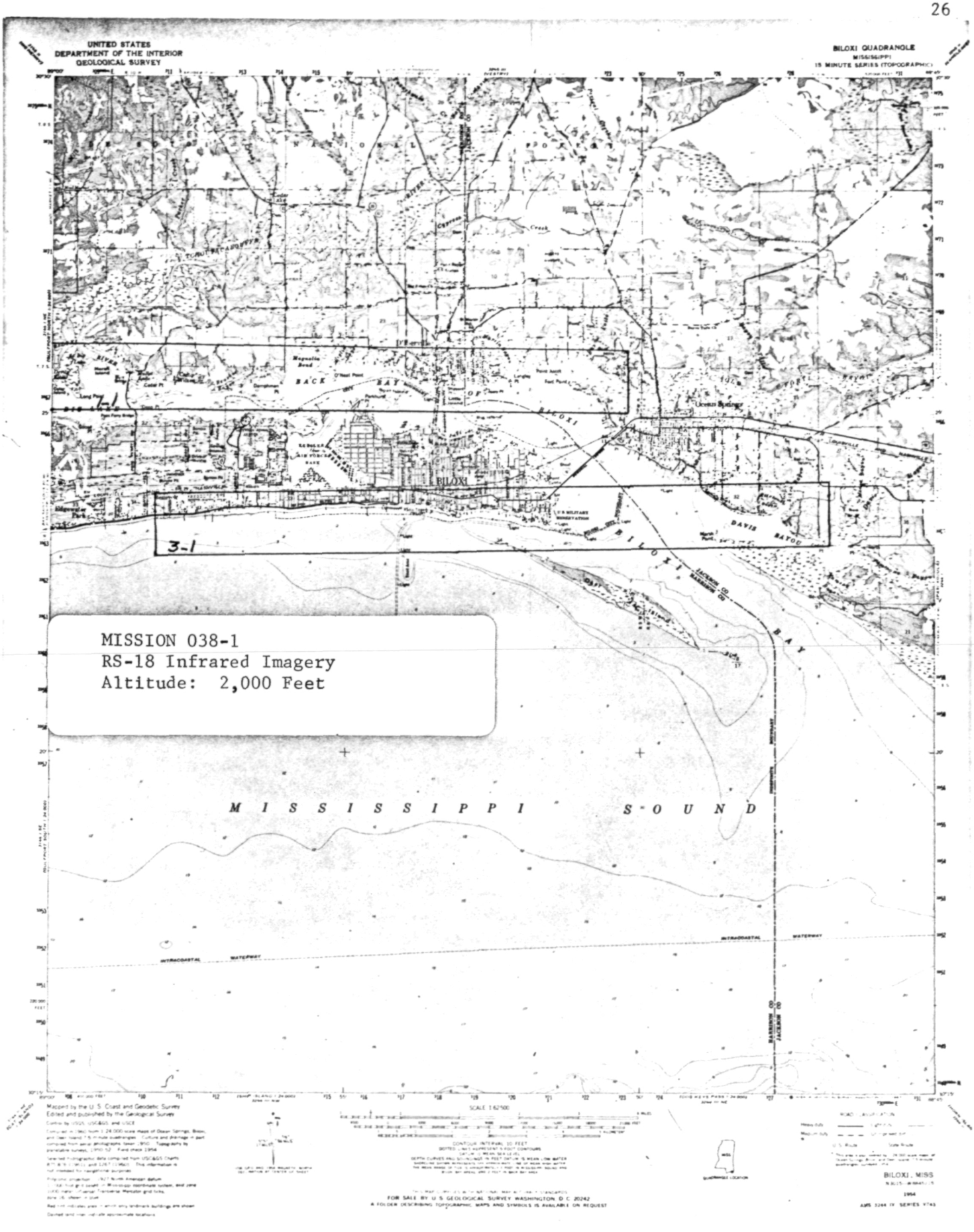
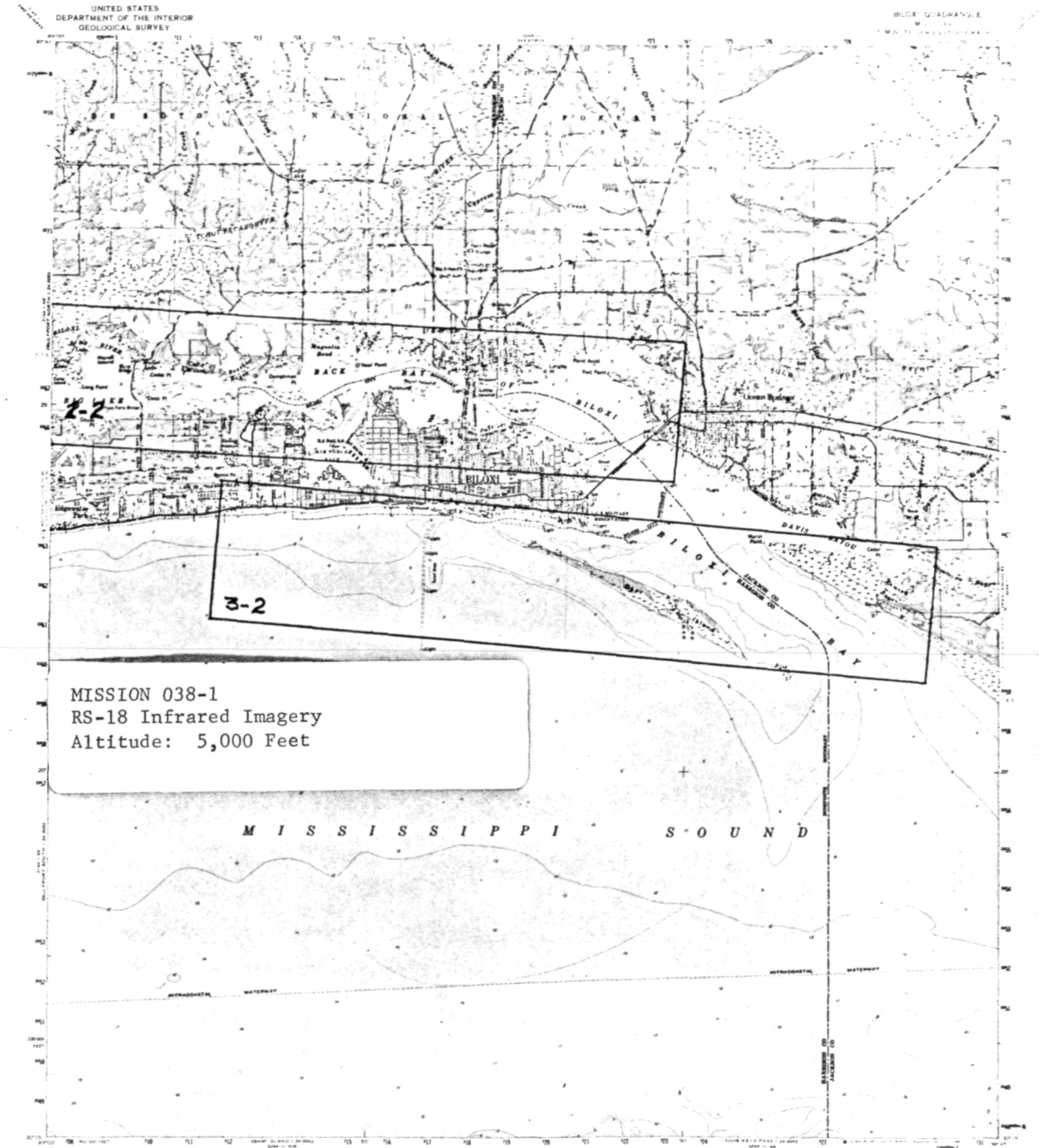
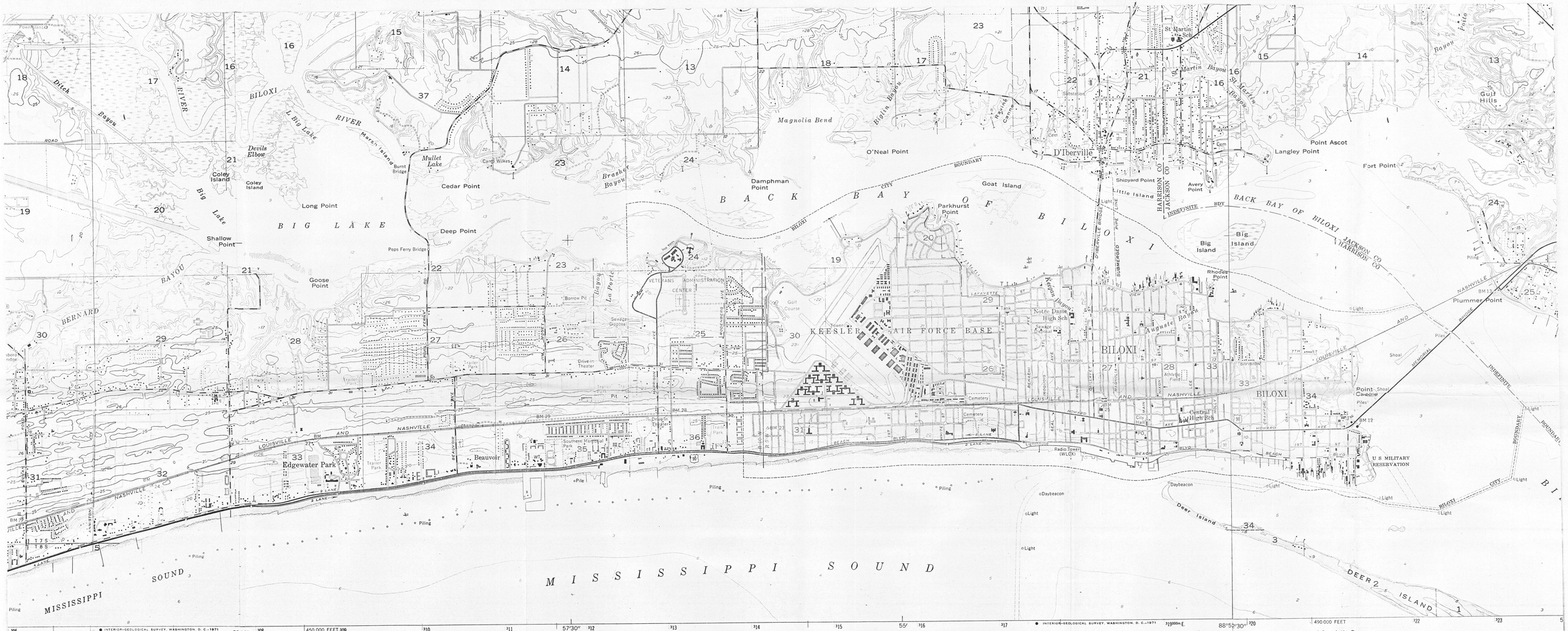

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
BILOXI QUADRANGLE
MISSISSIPPI
15 MINUTE SERIES (TOPOGRAPHIC)
LINE 1
LINE 2
LINE 3
MISSION 038-I
HASSELBLAD 40mm lens
Color (2448) Frames 001-065
Color IR (2443) Frames 127-197
Altitude: 2,000 Feet
MISSISSIPPI SOUND
BILOXI
BAY
INTRACOASTAL WATERWAY
SCALE 1:62500
CONTOUR INTERVAL 10 FEET
BILOXI, MISS
1954

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
BILOXI QUADRANGLE
MISSISSIPPI
15 MINUTE SERIES (TOPOGRAPHIC)
LINE 1
LINE 2
LINE 3
071
076
079
080
083
086
087
093
099
BILOXI
BIG LAKE
BACK BAY
DAVIS BAYOU
MISSISSIPPI SOUND
INTRACOASTAL WATERWAY
MISSION 038-I
HASSELBLAD 40mm lens
Color (2448) Frames 071-099
Altitude: 5,000 Feet


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
BILOXI QUADRANGLE
MISSISSIPPI
15 MINUTE SERIES (TOPOGRAPHIC)
LINE 1
LINE 2
LINE 3
101
103
106
107
110
111
114
116
MISSION 038-I
HASSELBLAD 40mm lens
Color (2448) Frames 101-116
Altitude: 10,000 Feet
MISSISSIPPI SOUND
BILOXI
BACK BAY
DAVIS BAYOU
BIG LAKE
INTRACOASTAL WATERWAY
Mapped by the U. S. Coast and Geodetic Survey
Edited and published by the Geological Survey
SCALE 1:62500
CONTOUR INTERVAL 10 FEET
ROAD CLASSIFICATION
BILOXI, MISS.
1954


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
BILOXI QUADRANGLE
MISSISSIPPI
15 MINUTE SERIES (TOPOGRAPHIC)
7-1
3-1
BILOXI
BACK BAY OF BILOXI
DAVIS BAYOU
BILOXI BAY
MISSISSIPPI SOUND
INTRACOASTAL WATERWAY
HARRISON CO
JACKSON CO
MISSION 038-1
RS-18 Infrared Imagery
Altitude: 2,000 Feet

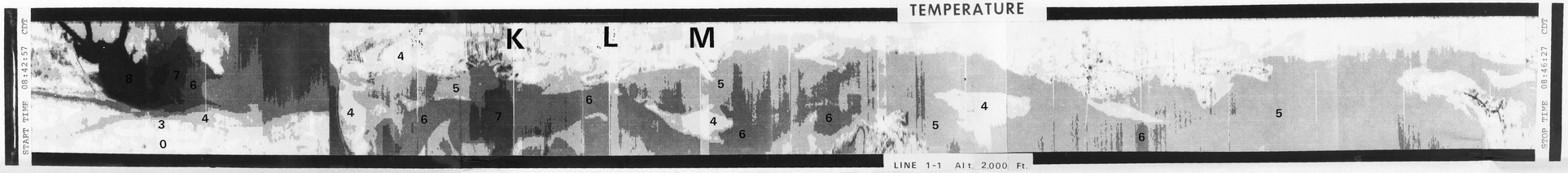

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
BILOXI QUADRANGLE
DE SOTO NATIONAL FOREST
BACK BAY OF BILOXI
BILOXI
DAVIS BAYOU
BILOXI BAY
MISSISSIPPI SOUND
INTRACOASTAL WATERWAY
2-2
3-2
MISSION 038-1
RS-18 Infrared Imagery
Altitude: 5,000 Feet
SCALE 1:62500
BILOXI, MISS.
1964


BACK BAY OF BILOXI
MISSISSIPPI SOUND
KEESLER AIR FORCE BASE
BILOXI
D'Iberville
Biloxi
Gulfport
Point Cadet
Point Ascot
Langley Point
Fort Point
Gulf Hills
Plummer Point
Rhodes Point
Big Island
Little Island
Shipyard Point
Avery Point
Parkhurst Point
Goat Island
O'Neal Point
Damphman Point
Magnolia Bend
Cedar Point
Deep Point
Long Point
Shallow Point
Goose Point
Coley Island
Devils Elbow
Mullet Lake
Edgewater Park
Beauvoir
Deer Island
DEER 2 ISLAND
Big Lake
L Big Lake
Marsh Island
Brashier Bayou
Biglin Bayou
St Martin Bayou
Bernard Bayou
Ditch Bayou
Back Bay
Big Island
Notre Dame High Sch
Central High Sch
Veterans Administration Center
Golf Course
Cemetery
Radio Tower (WLOX)
U S MILITARY RESERVATION
Pops Ferry Bridge
Burnt Bridge
Borrow Pit
Sewage Disposal
Drive-in Theater
Trailer Park
Southern Memorial Park
Pile
Piling
Daybeacon
Light
Boundary
Jackson Co
Harrison Co
Indefinite Bdy
City Limits
Pipe Line
Submerged
Nashville
Louisville and Nashville
Beach Blvd
Howard Ave
Division St
Lee St
Main St
Magnolia St
Reynoir St
Porter St
Forest Ave
Lafayette St
Fleet St
Augusta Ave
Keesler Blvd
Meaher Ave
Broadway
Pass Rd
Louisville St
Jefferson St
Veterans Memorial Bridge
Bridge
Pier
Shoal
Piles
Ruins
Pond
Cem
Tank
Substation
Spring
Camp Wilkes
Trailer Park
Golf Course
Cemetery
Athletic Field
City Hall
P.O.
Sch
Hosp
Tower
Pit
Drive-in Theater
Sewage Disposal
Borrow Pit
Trailer Park
Southern Memorial Park
Veterans Administration Center
Notre Dame High Sch
Central High Sch
Radio Tower (WLOX)
Cemetery
Golf Course
Athletic Field
City Hall
P.O.
Sch
Hosp
Tank
Substation
Spring
Camp Wilkes
Ruins
Pond
Cem

BILOXI BAY

August 8, 1972

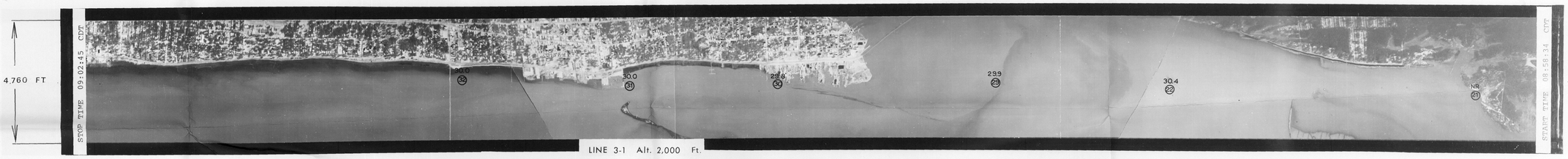
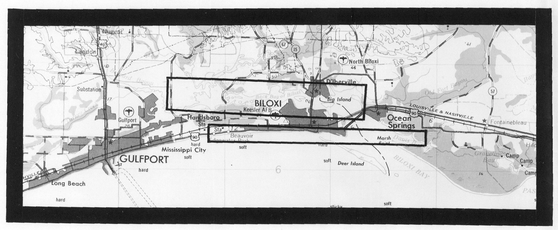
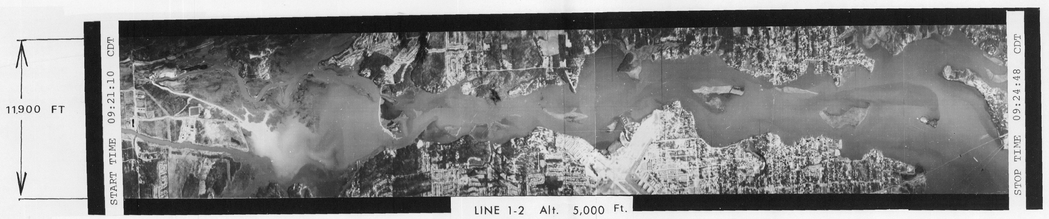
AIRBORNE RADIOMETRIC TEMPERATURE



LEGEND

TEMPERATURE °C	
0	0 to 28
3	28 to 29
4	29 to 30
5	30 to 31
6	31 to 32
7	32 to 33
8	33 to 34
9	34 to 36

RS-18 INFRARED IMAGERY

4,760 FT

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